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Effects of a Prescribed Fire in an Arizona Ponderosa Pine Forest

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A prescribed fire in 1964 consumed nearly three-fourths of the total forest floor. Eleven years after the fire, compaction of initial needle drop plus normal annual needle fall have created a forest floor depth two-thirds that of the prefire level. More ponderosa pine seedlings started on the burned areas than under adjacent unburned stands and herbage production increased, but not to levels adequate for grazing.

Keywords: Prescribed fire, litter production.

Introduction

In October 1964, a fire was set to burn approximately three-fourths of the forest floor depth in a ponderosa pine forest near Flagstaff, Arizona. Generally, this objective was accomplished (Davis, Ffolliott, and Clary 1968). Other effects of the fire included thinning of the forest overstory from below, increased seedling establishment, and a temporary reduction of fire hazard. Forage and browse remained practically unchanged.

The investigation described herein was conducted to assess the effects of this prescribed fire 11 years after burning on those characteristics originally modified by the burn.

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Methods

The fire prescribed was intended to consume three-fourths of the depth of a 1.5- to 3-inch layer of forest floor on two $\frac{1}{4}$ -acre areas (A and B). To this end, a surface fire with an average flame height of 2 feet was attained (fig. 1). The estimated fire intensities were 48 BTU's per second per foot on area A, and 90 BTU's per second per foot on area B. The specific conditions selected for achieving the prescribed fire have been summarized in an earlier report (Davis et al. 1968).

The density of the prefire even-aged forest overstory on area A was 170 square feet of basal area per acre, with an average tree diameter of 6 to 8 inches d.b.h. On area B, the even-aged overstory was 305 square feet of basal area per acre, with an average tree diameter of 14 to 16 inches d.b.h. On each area, 16 sample points were systematically spaced 25 by 25 feet. Data taken before burning, within 2 years after burning, and 11 years after burning include:



Forest floor depth: forest floor surface to mineral soil.

Timber density: estimated by point sampling with a basal area factor (BAF) gage of 25 at each sample point.

Seedling establishment: mil-acre plots stocked, 16 on and 16 adjacent to each burned area.

Herbage production: weight of grasses, forbs, and browse on 9.6-square-foot plots at each sample point.

Results and Discussion

The fire consumed 70% of the forest floor depth on area A, and 75% on area B, leaving 0.5 and 0.7 inch, respectively. In 2 years, litter on the burned areas had built up nearly to prefire levels, primarily because of a significant increase in needle drop immediately after the fire (Davis et al. 1968). However, 11 years after the fire, litter depth was less than it was 2 years after burning, probably as a result of compaction.

Eleven years after burning, the depth of the forest floor on area A was 0.8 inch, approximately 45% of the prefire depth of 1.7 inches. On area B, the depth was 1.2 inches, 40% of the prefire depth of 3.0 inches. Thus, in the 11 years since the fire, the additional needle fall that has accumulated on the 2 burned areas has been about 15% to 20% of the original forest floor depths. The current forest floor depths are approximately two-thirds those expected under unburned ponderosa pine stands of similar densities.

An unknown quantity of fire-killed twigs, branches, large limbs, and trees have fallen to the ground in the 11 years since the burn (fig. 2).

Figure 1.—Average flame height of the prescribed fire was approximately 2 feet.

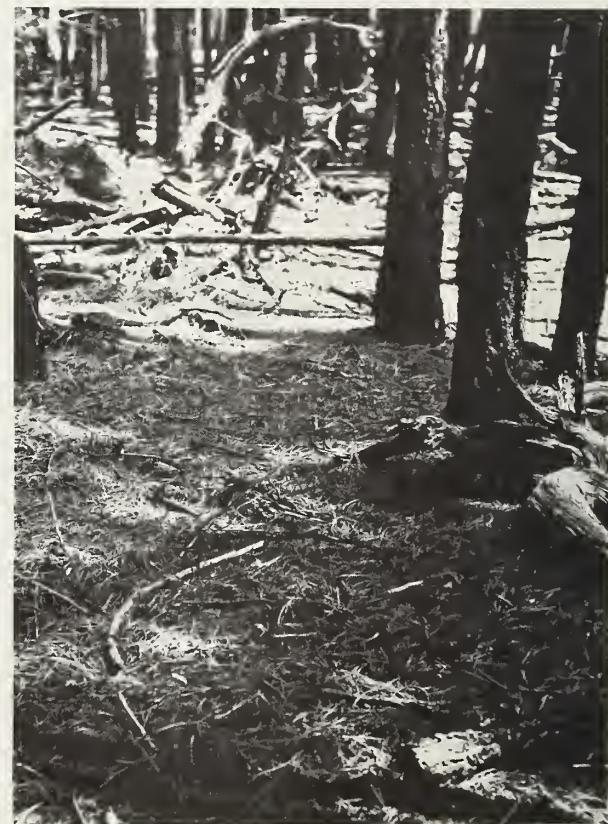


Figure 2.—Many twigs, branches, large limbs, and trees have fallen to the ground since the prescribed fire.

The general effect of the fire on the tree stand was a thinning from below. Area A lost 47% of its basal area, a reduction to 90 square feet per acre; area B lost 25%, a reduction to 235 square feet per acre. Eleven years after the fire, the basal area on area A had increased to 120 square feet per acre, indicating a growth rate of 3% annually. The basal area on B was 210 square feet per acre; however, less than that was recorded immediately after the fire. Apparently, enough trees initially damaged by the fire have subsequently died to offset the growth of residual trees.

Area A lost more of its original basal area because a greater proportion of the trees were of sapling size, which are much more susceptible to damage from ground fire than the pole size trees on area B. Both burned areas still contain too many trees for maximum wood production, however (Schubert 1974).

More ponderosa pine seedlings started on the burned areas than on adjacent unburned areas (fig. 3). One year after the fire, new seedlings

occupied 85% of the mil-acre plots on area A and 95% on area B, compared with 20% and 12%, respectively, adjacent to the burned areas. Many of these seedlings were short-lived; however, established seedlings occupied only 25% of the mil-acre plots on both of the burned areas 11 years after the fire. No plots adjacent to the burns still supported seedlings.

Herbage production on area A, which increased from 3 pounds per acre before the fire to 40 pounds 1 year after the fire, was also approximately 40 pounds per acre 11 years after the fire. However, the herbage composition had changed from primarily mullein (*Verbascum thapsus*), a relatively unpalatable plant, to a mixture of bottlebrush squirreltail (*Sitanion hystrix*), mutton bluegrass (*Poa fendleriana*), showy goldeneye (*Viguiera multiflora*), red-and-yellow-pea (*Lotus wrightii*), and buckbrush (*Ceanothus fendleri*). On area B, herbage production, which had remained at the prefire level of about 5 pounds per acre 1 year after the



Figure 3.—More ponderosa pine seedlings are growing on the burned areas than on the adjacent unburned areas.

fire, increased to 17 pounds per acre 11 years after the fire. The herbage composition on area B was similar to that on area A. Generally, the grazing values must be considered negligible on the two burned areas.

Management Implications

The future of prescribed burning in southwestern ponderosa pine seems favorable. A survivor of centuries of periodic wildfires, ponderosa should benefit from carefully prescribed burning programs. Prescribed fire can reduce wildfire hazard by removing dead material, litter, and part of the forest floor. Other benefits include overstory thinning from below, site preparation for seedling establishment, and increased forage production. While forage production was inade-

quate for grazing on this study site, burning on more productive sites, or in lower density stands, may result in sufficient forage for wildlife or domestic grazing.

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